TECHNICAL GUIDANCE

Coupling Geothermal Heat Pumps (GHP) With Underground Seasonal Thermal Energy Storage (USTES)

ESTCP Project EW-201135

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The objective of this demonstration was to fully maximize the inherent advantages of the geology and hydrogeology accessed by means of Ground-loop Heat Exchangers (GHX) with closed loop systems or via direct ground water use with open-loop systems, which conventional GHP systems in the U.S. are not designed to achieve. Deliberately engineered UTES systems not only allow for the waste heat of cooling systems and the waste cool of heating systems to be captured, but also allow for the out-of-season capture of the winter's "cold" or summer's "heat" (from the air or via solar thermal collectors), if needed, in cooling-dominated or heating-dominated buildings, respectively.

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TECHNICAL & ENVIRONMENTAL GUIDELINES

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ENVIRONMENTAL GUIDELINES

1.0 INTRODUCTION TO THE REPORT

Underground Thermal Energy Storage (UTES) is a form of energy storage that can efficiently utilize renewable energy at a large scale. The principal UTES technologies are Aquifer Thermal Energy Storage (ATES) and Borehole Thermal Energy Storage (BTES). These technologies have the potential to significantly reduce the energy load and carbon emissions associated with temperature air conditioning in residential commercial and institutional buildings of all sizes. (Velvis, 2015, Lee, 2010; Shennan and Snijders, 2006, Pyne, 2005). The concept behind these technologies goes back to 1912 when the first ground source heat pump was patented by Heinrich Zoelly in Switzerland, but ATES and BTES are relatively new in the sphere of what is accepted and established in the United States.

ATES and BTES involve penetrating the subsurface via vertical drilling. For ATES, this also includes intercepting aquifers and groundwater. For BTES, it includes accessing geologic formations with the capability of storing heat. This poses a potential impact on groundwater resources, which is always present when the subsurface is accessed through vertical drilling, horizontal trenching, or boring techqiues.

During installation, surface activities may also lead to effects on groundwater via accidental surface spills during handling and/or disposal of materials. That being said, it has long been recognized that properly designed and installed systems can access the potential of sub-surface storage of heat without adverse impacts to water resources (US Department of Energy, 1981, ATES Research, 2012).

Whereas UTES systems have been operating successfully in Europe since the late 1980s (Patsoy et al., 2009), the US has been slow to adopt the technology. For example, in Sweden there were over 10 ATES systems in 2012 (Andersson, 2013) and 2,740 in the Netherlands, (CBS, 2013). It has been estimated that about 20,000 ATES systems could be installed in the Netherlands by 2020, (Godschalk, 2009).

This report outlines some of the environmental issues related to ATES and BTES installation in the US. The report has been prepared by the American Ground Water Trust (AGWT) to accompany the state-by-state spreadsheet of regulatory requirements. AGWT is a national nonprofit water resource education organization focused on educating the public, business, government, communities and citizens about the importance and value of the nation’s ground and surface water resources. The sustainable use of water resources and implementation of the best technologies and resource management programs is the heart of the AGWT’s education outreach to attain the highest and best use of the resource among competing environmental, economic and social demands. Sound science should be the foundation for decisions leading to long-term sustainable water use and management programs that will stand the test of time.

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2.0 BACKGROUND TO ATES AND BTES IN THE US

In 1892, Boise, Idaho became the first community to use the natural high temperature water for a community heating system (Office of Energy Efficiency, 2012). The first documented residential use of "low temperature" ground source heating and cooling geothermal heat pumps (GHPs) was in 1948, when Professor Carl Nielsen of Ohio State University installed a system in his home. At the same time, an engineer named J.D. Knocker explored the application of a groundwater sourced heat pump system in a commercial building in Portland, Oregon (Office of Energy Efficiency and Renewable Energy, 2012). *Life* magazine published an article (Fireless Furnace, 1948) that same year showcasing the General Engineering and Manufacturing Company's "Miracula" ground source heat pump system, but still, low temperature GHP systems began did not get widespread entrepreneurial attention until the 1970's oil price shock.

The high fossil fuel prices fostered a nascent "open-loop" GHP system industry, followed by early innovations of closed loop installations using new-to-market plastic pipe products made from polybutylene and polyethylene. Today, polybutylene plastic pipe is not used in the GHP closed loop industry because it had a high failure rate in certain situations. High density polyethylene (HDPE) and PEX (cross-linked polyethylene) pipe are now the standard options per guidance from the International Ground Source Heat Pump Association (IGSHPA), a nonprofit organization formed in 1987 and headquartered at Oklahoma State University. The organization developed a set of guidance documents and training certifications that cover the design, installation and operation methods and scientific concepts that underpin the GHP industry (IGSHPA, 2012).

Through the 1980s up to the first few years of the 21st century, GHP installations represented only a small fraction of the heating, ventilation and air conditioning market. The Air Conditioning Heating and Refrigeration Institute (AHRI) reported from manufacturer's data that GHP shipments in 2008 indicated that about 2.6 percent of new homes installed a GHP system, up from less than 0.5 percent just a few years before (AHRI, 2012). As the absolute number of GHP installations has grown and become more visible and accepted in the built environment, many state environmental regulation agencies now recognize that loop fields, both open and closed, represent a possible threat to groundwater.

In cooperation with experts from the geothermal heat pump industry and experts from the heating and air conditioning industry, the AGWT convened seventy seven education forums and workshops across the country on GHP technology and groundwater impacts between 2007 and 2016. The principal target audiences for these events were architects and developers. Over this ten year period the AGWT has witnessed a significant increase in attention by state regulatory agencies because of the environmental implications of drilling operations. Regulatory guidelines for water wells were typically invoked as the basis for regulating ground source heat pump installations. In some cases new regulations were to address the possible effects of interaction between GHP loop fields and groundwater. Each state has taken a slightly different approach to regulating GHP loop fields. There is no overarching regulatory framework at the federal level that specifically targets GHPs although federal underground injection control rules may apply.

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3.0 HOW ATES AND BTES SYSTEMS WORK

ATES is an open-loop energy storage system that uses groundwater as the energy transfer medium between the ground and the conditioned building. Other components needed for an ATES system are heat exchangers, piping, mechanical systems and controls to integrate with the heating, ventilating and air conditioning system of the target building(s). It relies on seasonal storage of cold and/or warm groundwater in an aquifer. ATES is a nuanced application of the well-established "open-loop" ground source heat pump installations that have been in service across the United States since the 1970s. A traditional vertical open-loop well system draws groundwater from a supply well and discharges it to a receiving well and the flow direction is never reversed. However, an ATES installation extracts groundwater from source wells during one space conditioning season (heating) and discharges to aquifers via receiving wells in a nearby well field. During the (cooling) space conditioning season the flow direction is reversed. This process serves to enhance the groundwater temperatures (energy) in the receiving well relative to the required energy for the next conditioning season (cooler groundwater for the cooling season and warmer for the heating season).

ATES can provide an efficient system of heat storage and transfer with seasonal energy efficiency ratio values of over 60 (Underground Energy LLC, 2017). Efficiencies are measured as a ratio of thermal power output to electrical power input and ATES is typically four to six times more efficient than conventional heating and cooling systems. An ATES system uses natural heating and cooling and stores that heat in an aquifer until the following cooling or heating season. Provided there is not a dynamic flow system, an aquifer can effectively serve as a place to store and recover heat. Because a relatively large site foot-print is required for both cool and warm storage, ATES is not suitable for single a residential property but presents great opportunities for commercial, industrial and institutional buildings and campuses.

BTES geothermal systems operate on a similar principle as ATES, with underground storage of thermal energy. BTES systems are closed loop field installations with heat storage in the geology conveyed underground by fluids in a closed system that to not connect or have contact with groundwater. BTES does not need to be installed in water bearing rock formations and is suitable for both small and large scale applications. The system uses plastic piping to carry a water-based energy transfer fluid between the loop field and the geothermal heat pumps (GHPs). In a traditional closed loop design the loop field must be sized to balance the difference between the heating and cooling loads of the building, which requires matching the dominant building load and accounting for the climate conditions that renew the ground energy.

According to Underground Energy LLC, (2017) BTES is an improvement on conventional closed-loop ground source heat pump geothermal systems. In BTES the ground heat exchanger array system is designed and operated so that heat is stored or abstracted seasonally. In conventional geothermal the loops are designed to simply dissipate heat (or cold) into the subsurface. The analogy is that BTES uses the subsurface geology as a thermal battery, as opposed to a radiator. BTES is a design solution in areas where there are not aquifers suitable for ATES or where there may be concerns about the quality of the groundwater or the potential risks to groundwater. BTES systems do not connect with groundwater and may therefore have a lower threshold for permitting than ATES systems.

In a BTES design there is typically a compact radial loop field constructed through a cylindrical volume of rock. Flow and heat transfer through the vertical loops is designed to build heat in the core of the field during the cooling season and extract it during the heating season. The energy transfer fluid is directed to or from the core of the field depending on the conditioning needs of the building.

4.0 REGULATIONS RELATED TO ATES AND BTES INSTALLATIONS

Throughout the US, in virtually all instances, permits are required for any process that involves drilling into sub-surface formations and particularly when such drilling may impact water resources. Regulation for source water protection are promulgated and enforced mostly at the state and local municipal levels of government. ATES and BTES design and installation permits and approvals are not consistently handled by the same agencies state by state although ATES projects fall under the federal underground injection regulations. Most states have primacy for administering these regulations although some are handled via staff in US Environmental Protection Agency regional offices. State by state regulatory and reporting requirements are detailed in the spread-sheet accompanying this report. The information provided is categorized under the following headings:

- Agency issuing Underground Injection Control Permits
- State Agency regulating wells producing water
- State agency regulating non-producing boreholes
- Other units of government if part of permit process
- Open-loop permit requirements
- Closed-loop permit requirements
- Closed-loop post-installation inspection/ reporting requirements
- Open-loop post-installation inspection/ reporting requirements
- Open-loop driller license requirements
- Closed-loop driller license requirements
- Are out of state drillers allowed to perform work?
- Comments on driller continuing education requirements
- Additional Notes and Comments
- Additional information source(s) contact information
- URL of state agencies

4.1 CLOSED LOOP REGULATIONS (BTES)

BTES installations are similar to a traditional closed loop geoexchange field in that they both use plastic pipe as a conduit for heat exchange fluid flow between the GHP(s) and the loop field. They both incorporate a heat exchange fluid to collect and transport energy from the ground to the GHP in a continuous route with on-going flow when the GHP is in operation. During this review of the regulatory conditions surrounding closed loop geoexchange fields no indication was found that BTES would be treated differently than a large traditional closed loop geoexchange field. In most states closed loop geoexchange fields are regulated by extension of established water well construction regulations. No BTES systems have yet become operational recently in the United States.

Closed loop geoexchange loop fields as the proxy for BTES installations are not regulated specifically at the federal government level. Regulatory agency representatives at AGWT education programs have frequently informed their audiences that state regulations on ground source heat pump installations are still evolving. Most states require individuals who construct closed loop geoexchange systems incorporating vertical boreholes to be licensed, registered or certified water well drilling contractors

4.2 "OPEN-LOOP" REGULATIONS (ATES)

ATES and BTES system regulations are principally concerned with protection of groundwater quality. ATES installations are similar to a traditional vertical well open-loop geoexchange field in that they both use groundwater as the heat exchange fluid between the GHP(s) and the loop field and must return the groundwater to the subsurface via a series of wells. In most states, open-loop geoexchange systems are regulated by extension of established water well construction regulations. No ATES systems have been constructed and have become operational recently in the United States and so there is no precedent that can predict regulatory authorities' response to how they would implement oversight responsibility. The spread sheet information does list the existing rules and regulations that would apply to an "open-loop" ATES project.

"open-loop" geoexchange fields may be considered a proxy for ATES installations. ATES systems are not regulated directly at the federal government level. Because system operation calls for injection of groundwater, a few states require Underground Injection Control (UIC) permits for ATES installations. Even although there is no drinking water consumption involved, most states regulate "open-loop" wells used for heat exchange as drinking water wells regarding setbacks, and construction materials and methods (i.e., casing and grouting, etc).

Environmental permits are driven by water quantity and quality concerns. The direct access to groundwater in "open-loop" systems creates a situation for potential contamination or over-use conditions. To date, "open-loop" installations have been on a residential lots and/or situations where available water was sufficient to avoid conflicts between neighboring properties. As systems become more common in new construction projects and perhaps sited on multiple adjacent properties, it may become more common for state regulatory agencies to require water withdrawal permits for "open-loop" well fields. (Industry Insights, 2010).

5.0 ENVIRONMENTAL IMPACTS

ATES and BTES systems are not regulated directly by the U.S. Environmental Protection Agency (EPA) and to date there are no installation or operational experiences of environmental impacts. One 1,600 ton system has been operating at Richard Stockton College in Galloway, New Jersey since January 1994 (Richard Stockton College, 2013). In contrast, systems have been operating successfully in Europe since the late 1980s (Patsoy et al., 2009). The many ATES systems in the Netherlands (Godschalk and Bakema, 2011) demonstrate the practical utility of the technology and give a strong indication that there are not significant environmental issues.

Environmental impacts to subsurface conditions associated with ATES and BTES installations may result from four categories: hydrological, thermal, chemical or microbiological. The degree of the impact will depend on the operational characteristics of the UTES system and the state of the anthropogenic and natural environments of the installation site and surrounding land area (Evans et al., 2009). UTES systems have the potential to affect both surface and subsurface conditions (Ferguson, 2009). (Philippe et al 2017).

Hydrological impacts may result from the dynamic changes to groundwater quantity within an aquifer as the ATES pumping and recharge regime adjusts to meet seasonal heating and cooling demands throughout the year. Bonte et al (2011) reviewed the fundamental hydrogeological impacts that may occur as the result of operating an ATES system near a dedicated extraction well. ATES pumping and recharge create disturbances in aquifer flow patterns and water levels. If these changes intersect the design-capture zone of proximal dedicated extraction wells the design capture zone limits will increase or decrease to some extent reflecting either the ATES' cone of depression associated with the pumping field or the groundwater mounding geometry around the reinjection field, respectively. Because of the seasonal reversal of the ATES pumping and injection locations, the design-capture zone of a proximal dedicated extraction well could be in flux for extended periods through the year creating potential unintended interference and water mixing conditions. If one of the ATES wells is sited within the extraction well design-capture zone, groundwater from outside the design limit will be introduced to the extraction well water budget when the ATES system reinjects at this location.

Groundwater-surface water interactions may be affected by the periodic mounding and depressing of the water table near ATES systems. The interactions may be additive or subtractive with regard to surface water availability with consequent effects on the flora and fauna of the impacted habitat. ATES sites near wetlands or areas of potential salt water intrusion should be evaluated to identify possible changes to the ecology of these areas resulting from transient pumping and injection activities.

Cross-contamination of aquifers may occur when the ATES production wells and injection wells access different aquifers separated by low-permeability rock layers (aquitards and aquicludes) (Santi et al., 2006). ATES and BTES systems may also cross-contaminate aquifers or provide access for surface water contamination if borehole construction is poor including unsatisfactory grout placement due to inadequate quantity and/ or quality (Bonte et al., 2013). Debonding of the grout from the heat-transfer piping in BTES systems may occur due to differential thermal expansion between the materials potentially creating preferential pathways between aquifers and/ or the surface (Philippacopoulos and Brendt, 2001; Mehnert, 2004).

The Illinois Geological Survey found that Mix 111 (a thermally enhanced grout developed by the Brookhaven National Laboratory) did not debond and maintained hydraulic conductivities below 10^{-7} cm/sec during testing (McNulty and Rowe, 2000; Mehnert, 2004).

The development of conventional geoexchange heating and cooling systems to this point in time generally has been on property with few, on-site above ground or underground limitations or competing off-site water demands (Ferguson, 2009). In recent years, the geoexchange industry has seen the installation of increasingly larger systems (Dougherty 2012) such as the 9,000 borehole closed loop installation at Ball State University in Indiana (Ball State University, 2013). Installations in more urban, densely built environments such as New York City are also becoming more common and receiving added recognition from government leaders (Franks, 2013).

As UTES systems become larger and more closely spaced, the potential for system problems related to interference between proximal systems increases. Industry and government design and oversight professionals must recognize these potential situations to design and construct sustainable UTES systems that avoid conflicts. ATES systems may be unsustainable and fail due to thermal issues under three scenarios:

(1) Insufficient water supply;

(2) Increases (or decreases) in temperature of the production well water source due to on-site reinjection;

(3) Increases (or decreases) in temperature of the production well water source due to off-site injection (Ferguson and Woodbury, 2006).

On an annual basis, the temperature variation in ATES well fields is on the order of 10 degrees Celsius. The temperature range for BTES systems will be somewhat higher (Bonte et al., 2011). If the system is not in long- term thermal balance then the geoexchange system temperatures may drift over time. The “cold field” will get progressively colder, or the “warm field” will get progressively hotter unless chillers or boilers are added to keep the system in overall balance. Out of balance systems will degrade in efficiency as the stored energy rises (or falls) and potentially results in migration out of the system-design temperature interval. This was demonstrated in a study of an aquifer in Winnipeg, Canada that was used solely for cooling purposes. Injected water from several systems and within individual systems eventually broke through to the production wells compromising the efficacy of the systems. This indicates that there are minimum separation distances between production and injection wells that must be determined and maintained based on site specific conditions (Ferguson and Woodbury, 2006).

ATES installations mix groundwater as part of system operation by taking production water and injecting it back into the aquifer at a separate location. Mixing groundwater may alter the chemistry of the natural groundwater regime through redistribution of elevated concentration levels of natural minerals, anthropogenic contamination, pH, dissolved oxygen and dissolve solids/metals, etc. (Holm et al., 1987; Zuurbier et al., 2013). Substances that were substantially immobile under natural conditions may be solubilized and transported to the injection well location. Changing the thermal regime may enhance the mobilization process as Holm et al. (1987) reported with regard to quartz and calcium in recovered groundwater at a test ATES site.

However, water temperatures above 30 degrees Celsius may be required for temperature to have a significant role in altering mineral solubilities, reaction kinetics or organic matter oxidation (Bonte, 2011).

BTES systems may require the use of antifreeze in most installations to protect against freeze-up of the transfer fluid during the heating portion of the year in cold climates. Several antifreeze-water mixture options have been applied in the past including methanol, ethanol, potassium acetate, ethylene glycol, propylene glycol, calcium magnesium acetate (CMA) and urea (USEPA, 1998; Mehnert, 2004; Klotzbücher et al., 2007; IGSHPA, 2009). Non-toxic ("food-grade") propylene glycol is the most common antifreeze chemical used in the geoexchange industry today. Water-methanol antifreeze mixtures have superior pumping characteristics relative to propylene glycol, but many states have banned its use because of its toxicity profile. Geoexchange loop circuits incorporating High Density Polyethylene (HDPE) pipe that are assembled using properly applied industry standard thermal fusion methods and subsequently pressure tested prior to burial are unlikely to leak during operation unless the pipes are damaged during a future excavation event within the loop area.

Groundwater aquifers are ecosystems that only in the last two decades have begun to receive recognition and assessment on a level comparable to terrestrial and surface water habitats (Lovley and Chapelle, 1995; Goldscheider et al., 2006; Griebler and Lueders, 2009). Much of the research has focused on the use of microbes to remediate contaminated groundwater and less on the characteristics of the natural faunal communities. The current level of knowledge suggests generally that oligotrophic pristine aquifers characterized by limited carbon, energy and nutrient sources are either habitats with relatively low microbial biodiversity or are low abundance habitats that existing collection and evaluation methods are not precise enough to appropriately assess (Goldscheider et al., 2006; Lehman, 2007; Griebler and Lueders, 2009).

Changes to groundwater hydrogeochemistry and temperature are the main parameters of operating ATES and BTES systems that may alter aquifer ecology and potentially create risk (Hall et al., 2008). There is a paucity of information assessing aquifer vulnerability to these threats and consequent risk related to UTES (Bonte et al., 2011). The lack of risk assessment information may be due in part to the relatively nascent understanding of the natural aquifer conditions that would form the backdrop for quantifying threats, vulnerabilities and associated risks. At this time it appears setback requirements between UTES systems and potable water supplies remain an important and necessary part of preventing adverse impacts between these two groundwater use activities (Schijven et al., 2006; Bonte et al., 2011).

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APPENDIX A STATE BY STATE ENVIRONMENTAL REGULATORY AND REPORTING REQUIREMENTS

State by State Environmental Regulatory and Reporting Requirements

	ALABAMA	ALASKA	ARIZONA	ARKANSAS	CALIFORNIA
Agency issuing Underground Injection Control Permits	Joe Kelly, Alabama Department of Environmental Management, Water Division - Water Quality Program, 334-271-7844, jrk@adem.alabama.gov	Stephen Davies, Senior Petroleum Geologist, Alaska Oil and Gas Conservation Commission, 333 W 7th Avenue, Suite 100, Anchorage, AK 99501, 907-793-1224, steve.davies@alaska.gov	Luke Peterson, Aquifer Protection Permits, Arizona Department of Environmental Quality, 602-771-2322, peterson.luke@azdeq.gov	Jim Battreal - Arkansas, Division of Water Well Drilling 501-682-3904	Ken Harris, State Oil and Gas Supervisor, Natural Resources Agency, Department of Conservation, California Department of Oil, Gas and Geothermal Resources, 801K Street, MS 18-05, Sacramento, CA 95814, 916-323-1777, ken.harris@conservation.ca.gov. US EPA Region 9 office. In CA the State Water Resources Control Board & the Regional Water Quality Control Boards "Water Boards") can prescribe requirements for discharges into CA waters, including groundwater.
State Agency regulating wells producing water	Joe Kelly, Alabama Department of Environmental Management, Water Division - Water Quality Program, 334-271-7844, jrk@adem.alabama.gov	Stephen Davies, Senior Petroleum Geologist, Alaska Oil and Gas Conservation Commission, 333 W 7th Avenue, Suite 100, Anchorage, AK 99501, 907-793-1224, steve.davies@alaska.gov	AZ, Dept. of Water Resources, Groundwater Permitting and Wells Section, Stella Murillo, Manager (602) 771-8594, samurillo@azwater.gov. Regulates Water Wells.	Arkansas Water Well Construction Commission	Local enforcing agencies regulate water well construction, except for public supply wells (serving more than 200 service connections). Public supply wells are regulated by SWRCB Division of Drinking Water. The Water Boards have broad regulatory authority over groundwater protection in CA. In contaminated areas, the CA Dept. of Toxic Substances Control has regulatory authority over wells.
State agency regulating non-producing boreholes	Joe Kelly, Alabama Department of Environmental Management, Water Division - Water Quality Program, 334-271-7844, jrk@adem.alabama.gov	unknown	AZ Dept. of Water Resources	AR Department of Environmental Quality	These are treated as two different types in CA. Local agencies have authority but no mandate to regulate non-producing boreholes "exploratory borings" - some do and some don't. Per the CA Water Code, local agencies must regulate closed loops, which are referred to as "Geothermal Heat Exchange Wells (GHEWs)" in the Water Code.
Other units of government if part of permit process	None	None	None	None	The Water Boards have broad regulatory authority over groundwater protection in California. In contaminated areas, the CA Department of Toxic Substances Control has regulatory authority over wells.
Open-loop permit requirements	UIC permit	Regulation 20 AAC 25.705 grants the Alaska Oil and Gas OGCC jurisdiction over all geothermal drilling and production activities conducted on all land in the state lawfully subject to its police powers, including Federal lands. Regulations 20 AAC 25.710 through 20 AAC 25.740 governs these activities. By reference, Permit to Drill application requirements for geothermal wells are specified in 20 AAC 25.005.	Permit is required and wells must be registered at DWR	Unknown	The requirements for open-loops are the same as for water wells.
Closed-loop permit requirements	no UIC permit required	Regulation 20 AAC 25.705 grants the Alaska Oil and Gas OGCC jurisdiction over all geothermal drilling and production activities conducted on all land in the state lawfully subject to its police powers, including Federal lands. Regulations 20 AAC 25.710 through 20 AAC 25.740 governs these activities. By reference, Permit to Drill application requirements for geothermal wells are specified in 20 AAC 25.005.	Yes - wells must be registered at DWR	Class V Wells are "authorized" by the ADEQ	Local agencies set the permit process for closed looks.
Closed-loop post-installation inspection/ reporting requirements	unknown	Unknown	None	Authorized Class V wells are inspected	Post-installation inspection/reporting for closed-loops are the purview of the local enforcing agency. Reporting requirements are per the CA Water Code: a well completion report must be submitted to the State Department of Water Resources within 60 days of completion of construction.
Open-loop post-installation inspection/ reporting requirements	unknown	Unknown	None	Unknown	Open-loop post-installation inspection/reporting requirements are the same as for water wells: The local agency has authority to conduct inspections and well completion reports must be submitted to the State Department of Water Resources within 60 days of completion of construction.
Open-loop driller license requirements	Alabama Well Driller's License	Alaska requires water well contractors and well service companies to have a general or subcontractor's license, but not to be specifically certified for well construction.	Yes - Need to have a AZ Water Well Drillers License	Arkansas water well contractor license. Arkansas Registered Professional Engineers and Arkansas Registered Professional Geologists practicing geotechnical engineering or geologic investigations may be declared exempt from certification, bonding, and testing requirements upon application for exemption from the Commission.	Drillers for open loops must have a C-57 Water Well Driller's license from the CA Contractors State License Board.
Closed-loop driller license requirements	Alabama Well Driller's License	Alaska requires water well contractors and well service companies to have a general or subcontractor's license, but not to be specifically certified for well construction.	Yes - Need to have a AZ Water Well Drillers License	Arkansas water well contractor license. Arkansas Registered Professional Engineers and Arkansas Registered Professional Geologists practicing geotechnical engineering or geologic investigations may be declared exempt from certification, bonding, and testing requirements upon application for exemption from the Commission.	Per the Water Code, a C-57 license is required for closed-loops.
Are out of state drillers allowed to perform work?	Reciprocity to drillers from out of state will be considered on an individual basis.	unknown	No	Any person who contracts for or is engaged in well construction or pump installation shall hold or be employed by a person holding an Arkansas Water Well Contractor License.	Only if they7 have a C-57 license
Comments on driller continuing ed requirements	unknown	unknown	No CE requirement	Required	Unknown
Additional Notes and Comments	none	AOGCC has regulatory authority over all wells drilled in search of, or in support of the recovery of, geothermal resources and has not yet regulated any such geoexchange loop system	WDR regulates wells in the 5 active management areas (comprised of 5 metropolitan areas). Outside of these areas there are not regulated.	none	none
Additional information source(s) contact information	none	none	none	Linda Hanson, ADEQ, Permitting Branch, Office of Water Quality, 501-682-0646	Julie Haas, CA DWR - Julie.Haas@water.ca.gov
URL of state agencies	http://www.adem.state.al.us/alEnviroRegLaws/files/Division6Vol1.pdf	http://www.legis.state.ak.us/basis/aac.asp#20.25.705	http://legacy.azdeq.gov/environ/water/permits/app.html. http://www.azwater.gov/azdwr/.	www.adeq.state.ar.us. www.arkansas.gov/awwcc	http://www.conservation.ca.gov/dog/general_information/Pages/class_injection_wells.aspx; http://www.water.ca.gov/groundwater/wells/standards.cfm

	COLORADO	CONNECTICUT	DELAWARE	DISTRICT OF COLUMBIA	FLORIDA
Agency issuing Underground Injection Control Permits	Omar Sierra-Lopez, Class V Well, U.S. EPA Region 8, (8WP-SUI), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov	Art Mauger, Connecticut Department of Energy and Environmental Protection, Water Permitting and Enforcement Division, art.mauger@ct.gov	Ronald Graeber, Program Manager, Ground Water Discharges Section, 89 Kings Highway, Dover, DE 19901, 302-739-9326,	Mark Nelson, EPA Region 3, Class V Team Leader and Technical Representative, UIC Class 5 Permitting and Rule Authorization, 1060 Chapline Street, Wheeling, WV 26003-2995, 304-234-0286, nelson.mark@epa.gov	Joe Haberfeld, Administrator, Aquifer Protection Program, Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3530, Tallahassee, FL 32399-2400, 850-245-8655, joe.haberfeld@dep.state.fl.us
State Agency regulating wells producing water	Unknown	Local Health Departments and Districts have the authority over private wells in their respective towns. Public Water Systems: CT Department of Public Health Drinking Water Section 410 Capitol Avenue, MS#12DWS P.O. Box 340308 Hartford, CT 06134-0308	State of Delaware, Division of Natural Resources and Environmental Control, Water Supply Section, Well Permits Branch is responsible for managing and issuing well construction and use permits for wells that withdraw 50,000 gallons or less of water daily.	DC Department of Energy and Environment/Water Quality Division reviews permit applications to install wells (see definition of wells below) in private and public space through the Department of Consumer and Regulatory Affairs and the District Department of Transportation. http://doee.dc.gov/service/wellpermits	Joe Haberfeld, Administrator, Aquifer Protection Program, Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3530, Tallahassee, FL 32399-2400, 850-245-8655, joe.haberfeld@dep.state.fl.us
State agency regulating non-producing boreholes	Unknown	CT Department of Consumer Protection 450 Columbus Boulevard, Suite 901 Hartford, Connecticut 06103-1840 - http://www.ct.gov/dcp/site/default.asp	Unknown	DC Department of Energy and Environment/Water Quality Division reviews permit applications to install wells (see definition of wells below) in private and public space through the Department of Consumer and Regulatory Affairs and the District Department of Transportation. http://doee.dc.gov/service/wellpermits	Unknown
Other units of government if part of permit process	Colorado Division of Water Resources, Department of Natural Resources, 1313 Sherman Street, Suite 821, Denver, CO 80203, 303-866-3581	Unknown	None	http://doee.dc.gov/service/wellpermits	Florida Department of Environment, Florida Water Management Districts (5), 3900 Commonwealth Boulevard MS 49, Tallahassee, FL 23299, 850-245-2118
Open-loop permit requirements	All geothermal resources of the State of Colorado are administered by the State Engineer. Prior to issuance of a permit, the applicant must become certified. Use Form GX-02 in applying for certification and Form GWS-72 for a permit to construct geoexchange system loop fields.	Unknown.	Before any well construction activities commence to install any well, the property owner or property owner's authorized agent must obtain the prior approval of the Department of Natural Resources and Environmental Control to construct the well in the form of a well permit.	Unknown	Unknown
Closed-loop permit requirements	All geothermal resources of the State of Colorado are administered by the State Engineer. Prior to issuance of a permit, the applicant must become certified. Use Form GX-02 in applying for certification and Form GWS-72 for a permit to construct geoexchange system loop fields.	Unknown.	Before any well construction activities commence to install any well, the property owner or property owner's authorized agent must obtain the prior approval of the Department of Natural Resources and Environmental Control to construct the well in the form of a well permit.	Unknown	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Upon completion of the well, the water well contractor shall submit to the Department a legible well completion report and formation log	Unknown	Non-Major Class V wells are permitted through the FL Department of Environmental Protection district offices. These wells include domestic wastewater wells below the USDW, closed loop heat pump/ air conditioning return flow wells, swimming pool drainage wells, stormwater wells, and remediation wells.
Open-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Upon completion of the well, the water well contractor shall submit to the Department a legible well completion report and formation log		
Open-loop driller license requirements	Unknown	Well drillers must be licensed by the Department of Consumer Protection	All wells in Delaware must be constructed by a well driller or well driver licensed with State of Delaware, Division of Natural Resources and Environmental Control, Water Supply Section	Unknown	Florida Well Driller's License required
Closed-loop driller license requirements	Unknown	Well drillers must be licensed by the Department of Consumer Protection	All wells in Delaware must be constructed by a well driller or well driver licensed with State of Delaware, Division of Natural Resources and Environmental Control, Water Supply Section	Unknown	Florida Well Driller's License required
Are out of state drillers allowed to perform work?	Unknown	Well drillers must be licensed by the Department of Consumer Protection	All wells in Delaware must be constructed by a well driller or well driver licensed with State of Delaware, Division of Natural Resources and Environmental Control, Water Supply Section	Unknown	Florida Well Driller's License required
Comments on driller continuing ed requirements	Required.	Unknown.	Required.	Unknown	Regulated by Water Management District
Additional Notes and Comments	none	none	7102 Regulations Governing Underground Injection Control http://regulations.delaware.gov/AdminCode/title7/7000/7100/7102.shtml	Wells are defined by DC Law § 8-103.01(26A) as any test hole, shaft, or soil excavation created by any means including, but not limited to, drilling, coring, boring, washing, driving, digging, or jetting, for purposes including, but not limited to, locating, testing, diverting, artificially recharging, or withdrawing fluids, or for the purpose of underground injection.	Unknown
Additional information source(s) contact information	none	none	Unknown	Unknown	Unknown
URL of state agencies	http://water.state.co.us/groundwater/wellpermit/Pages/GeothermalWells.aspx	http://ct.gov/dcp/cwp/view.asp?a=1624&q=461654; https://eregulations.ct.gov/eRegsPortal/Browse/RCSA/%7B5A0198CF-C041-4299-B189-A2C1E4B10A39%7D	State of Delaware, Division of Natural Resources and Environmental Control, Water Supply Section - http://www.dnrec.delaware.gov/wr/Services/OtherServices/Pages/WaterSupplyWellsPermitBranch.aspx	Unknown	http://www.dep.state.fl.us/secretary/watman/default.htm

	GEORGIA	HAWAII	IDAHO	ILLINOIS	INDIANA
Agency issuing Underground Injection Control Permits	Edward Rooks, Georgia Environmental Protection Division, 2 MLK Jr. Drive S.E., Suite 1362 E, Atlanta, GA 30334-9000, 404-232-7818, edward.rooks@dnr.ga.gov	Morris Uehara, State of Hawaii, Department of Health, Safe Drinking Water Branch, 808-586-4258	Nathaniel Fischer, UIC Hydrogeologist, Idaho Department of Water Resources, PO Box 83720, Boise, ID 83720-0098, 208-287-4991, nate.fischer@idwr.idaho.gov	Bur Filson, Illinois Environmental Protection Agency, 1021 North Grand Avenue, Springfield, IL 62794, 217-782-6070, bur.filson@illinois.gov	Ross Micham, UIC Branch, U.S. EPA Region 5, 312-886-4237, micham.ross@epa.gov
State Agency regulating wells producing water	Edward Rooks, Georgia Environmental Protection Division, 2 MLK Jr. Drive S.E., Suite 1362 E, Atlanta, GA 30334-9000, 404-232-7818, edward.rooks@dnr.ga.gov	Morris Uehara, State of Hawaii, Department of Health, Safe Drinking Water Branch, 808-586-4258	Unknown	Bur Filson, Illinois Environmental Protection Agency, 1021 North Grand Avenue, Springfield, IL 62794, 217-782-6070, bur.filson@illinois.gov	IN Dept. of Natural Resource, 402 West Washington Street Indianapolis, IN 46204, http://www.in.gov/dnr/
State agency regulating non-producing boreholes	Unknown	Unknown	Unknown	Unknown	IN Dept. of Natural Resource, 402 West Washington Street, Indianapolis, IN 46204, http://www.in.gov/dnr/
Other units of government if part of permit process	Unknown	Unknown	Unknown	County Health Dept.	21 Counties have a well ordinance and some municipalities also regulate water wells
Open-loop permit requirements	Open-Loop are prohibited	UIC Permit required	Unknown	UIC Requirements, minimum of submission of Class V injection well inventory information	Not at State level, some on County level.
Closed-loop permit requirements	File Notice of Intent	not sure	Unknown	Not regulated by UIC	Not at State level, some on County level.
Closed-loop post-installation inspection/ reporting requirements	Unknown	not sure	Unknown	Unknown	Not that DNR is aware of
Open-loop post-installation inspection/ reporting requirements	n/a	"A" General Engineering Contractor License or a Injection Well (C-57b) License or a Well Contractor (C-57) License is required			Not that DNR is aware of
Open-loop driller license requirements	n/a	not sure	Well Driller's License required		IN Water Well Drilling license
Closed-loop driller license requirements	Well Driller's License required	not sure	Unknown	Unknown	IN Water Well Drilling license
Are out of state drillers allowed to perform work?	Unknown	not sure	Unknown	Unknown	Must have IN Water Well Driller License
Comments on driller continuing ed requirements	Continuing Ed required	Unknown	Continuing Education Required per Rule 70 (https://adminrules.idaho.gov/rules/current/37/0310.pdf)		Required. Beginning with the 2011 license year, a person who has held a well driller license for at least one (1) calendar year must complete at least six (6) hours of approved continuing education during each two year cycle to be eligible for license renewal.
Additional Notes and Comments	Unknown	UIC Program is regulated under Hawaii Administrative Rules Title 11, Department of Health, Chapter 23	Unknown	Unknown	Rule 8. Other Wells and Structures, 312 IAC 13-8-1 Geothermal heat pump wells, Authority: IC 14-10-2-4; IC 25-39-4-2; IC 25-39-4-9, Affected: IC 25-39, Sec. 1. (a) This section establishes standards for drilling ground water heat pump systems that are in addition to the general requirements for drilling a well under 312 IAC 12. (b) If a return well is used with an open loop system, its design must provide water transmitting capacity that is at least one and one-half (1 1/2) times the required water supply of the heat pump unit. (c) With respect to a vertical closed loop system, boreholes must be pressure grouted from the bottom of the borehole to the ground surface with a neat cement or high solids bentonite grout that, to enhance thermal conductivity, may contain any of the following: (1) Sand. (2) Graphite. (3) Another material approved by the division. (Natural Resources Commission; 312 IAC 13-8-1; filed Nov 22, 1999, 3:34 p.m.: 23 IR 770; readopted filed Aug 4, 2005, 6:00 p.m.: 28 IR 3661; filed Jul 14, 2006, 1:23 p.m.: 20060809-IR-312050341FRA; readopted filed May 20, 2011, 3:28 p.m.: 20110615-IR-312110002RFA; filed Jan 23, 2015, 10:22 a.m.: 20150218-IR-312140204FRA)
Additional information source(s) contact information	Unknown	http://health.hawaii.gov/opppd/files/2015/06/11-23appa.pdf (Amendment). Licensing: http://cca.hawaii.gov/pvl/boards/contractor/	Unknown	Rick Cobb, 217-524-5377, rick.cobb@illinois.gov	Monique Riggs, IN Department of Natural Resources, Water Rights & Use, Division of Water, 402W Washington St, Rom: W264, Indianapolis, IN 46204, 317-234-1085, mriggs@dnr.in.gov
URL of state agencies	Unknown	http://health.hawaii.gov/opppd/files/2015/06/11-23.pdf; http://health.hawaii.gov/opppd/files/2015/06/11-23appa.pdf (Amendment)	http://idwr.idaho.gov/wells/injection-wells.html; http://idwr.idaho.gov/wells/forms.html; http://idwr.idaho.gov/wells/driller-licensing.html	IL EPA UIC Program http://www.epa.illinois.gov/topics/waste-management/underground-injection-control/index	IN Department of Natural Resources, http://www.in.gov/dnr/. IN Department of Environmental Management, http://www.in.gov/idem/5221.htm

	IOWA	KANSAS	KENTUCKY	LOUISIANA	MAINE
Agency issuing Underground Injection Control Permits	Kurt Hildebrandt, US EPA Region 7, Water, Wetlands & Pesticides Division, 11201 Renner Boulevard, Lenexa KS 66219, 913-551-7413, hildebrandt.kurt@epa.gov	Brandy DeArmond, Kansas Department of Health and Environment, UIC Program, 785-296-5444, bdearmond@kdheks.gov	Robert Olive, GW/UIC, US EPA Region 4, 61 Forsyth Street SW, Atlanta, GA 30303-8960, 404-562-9423, olive.robert@epa.gov	Steve Lee, Direction, Injection & Mining Division, Louisiana Department of Natural Resources, Office of Conservation, PO Box 94275, 225-342-5569, stephen.lee@la.gov	Bill Hinkel, Maine Department of Environmental Protection, Division of Water Resource Regulation,bill.hinkel@maine.gov
State Agency regulating wells producing water	Russell Tell, Environmental Specialist Senior, Wallace State Office Building, 502 E 9th Street, Des Moines, IA 50319-0034, 515-725-0642, russell.tell@dnr.iowa.gov	Brandy DeArmond, Kansas Department of Health and Environment, UIC Program, 785-296-5444, bdearmond@kdheks.gov	Scotty Robertson, Kentucky Department of Environmental Protection, Division of Water, Water Well Drillers Certification Program Coordinator, Watershed Management Branch, 300 Sower Boulevard, Frankfort, KY 40601, 502-782-7054, scotty.robertson@ky.gov	Unknown	Bill Hinkel, Maine Department of Environmental Protection, Division of Water Resource Regulation, bill.hinkel@maine.gov and Maine Well Drillers Commission, http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/wellDrillers.shtml
State agency regulating non-producing boreholes	Russell Tell, Environmental Specialist Senior, Wallace State Office Building, 502 E 9th Street, Des Moines, IA 50319-0034, 515-725-0642, russell.tell@dnr.iowa.gov	Unknown	Unknown	Unknown	Bill Hinkel, Maine Department of Environmental Protection, Division of Water Resource Regulation, bill.hinkel@maine.gov and Maine Well Drillers Commission, http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/wellDrillers.shtml
Other units of government if part of permit process	Unknown	Unknown	Unknown	Unknown	None
Open-loop permit requirements	All closed loop systems that are 20 feet or greater in depth and all open loop systems require the issuance of a private well construction permit before any loop drilling, trenching, or boring takes place.	Unknown	No permit required from Kentucky Division of Water, but plumbing and construction permits maybe required by other agencies.	Unknown	Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.)
Closed-loop permit requirements	All closed loop systems that are 20 feet or greater in depth and all open loop systems require the issuance of a private well construction permit before any loop drilling, trenching, or boring takes place.	Unknown	No permit required from Kentucky Division of Water	Unknown	Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.)
Closed-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Unknown	Unknown	Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.)
Open-loop post-installation inspection/ reporting requirements			Certified water well driller must file report of open-well loop within 60 days of construction to the Kentucky Division of Water per Kentucky Administrative Regulation 401 KAR6:310.		Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.)
Open-loop driller license requirements	Iowa DNR Certified Well Contractor (http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Private-Well-Program/Contractor-Certification)	Unknown	Water well driller certification required	Unknown	Must be licensed with the Maine Well Drillers Commission
Closed-loop driller license requirements	Iowa DNR Certified Well Contractor (http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Private-Well-Program/Contractor-Certification)	Unknown	No license required by Kentucky Division of Water at this time.	Unknown	Must be licensed with the Maine Well Drillers Commission
Are out of state drillers allowed to perform work?	Unknown	Unknown	Unknown		Must have a Maine license for the work proposed
Comments on driller continuing ed requirements	Required.	Unknown	Unknown	Unknown	Not required.
Additional Notes and Comments	Unknown	Unknown	Unknown	Unknown	03/21/2017: ME Well Drillers Commission has advised licensees that the Internal Plumbing Code does not allow the use of a potable water source (well) for the disposal of the return water from an open-loop system. A second well for return water is required per the Internal Plumbing Code.
Additional information source(s) contact information	Iowa DNR is developing a new general permit. This permit would authorize discharges from the following activities: Excavation dewatering associated with construction activity, Temporary groundwater dewatering to facilitate construction activity, Residential open-loop geothermal heating and cooling systems (8/26/16)	Unknown	Kenya Stump, Assistant Director, Kentucky Department for Energy Development and Independence, Division of Renewable Energy, 500 Mero Street, 12th Floor, Frankfort, KY 40601, 502-782-7083, kenya.stump@ky.gov; http://energy.ky.gov/renewable/Pages/GeothermalEnergy.aspx	Unknown	Enid Mitnik, enid.mitnik@maine.gov, ME DEP, Bureau of Water Quality, Underground Injection Control, 17 Sate House Station, Augusta, ME 04333. 207-592-2068
URL of state agencies	http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Private-Well-Program/Construction-Permits	Unknown	Open loop vertical geoexchange wells fall under Kentucky's Statute KRS 223.400 http://www.lrc.ky.gov/Statutes/statute.aspx?id=9973 and Kentucky Administrative Regulation 401 KAR6:310 http://www.lrc.ky.gov/kar/401/006/310.htm; KY statute KRS 223.405 http://www.lrc.ky.gov/Statutes/statute.aspx?id=9974	http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=141&pnid=29&nid=81	Maine Department of Environmental Protection - http://www.maine.gov/dep/. Maine Well Drillers Commission: http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/wellDrillers.shtml

	MARYLAND	MASSACHUSETTS	MICHIGAN	MINNESOTA	MISSISSIPPI
Agency issuing Underground Injection Control Permits	Dr. Ching-Tzone Tien, Chief, Groundwater Permits Division, Water Management Administration, Maryland Department of the Environment, 1800 Washington Boulevard, Baltimore, MD 21230, 410-537-3662, chin-tzone.tien@maryland.gov	Joe Cerutti, Massachusetts Department of Environmental Protection, UIC Program/Drinking Water Program, 1 Winter Street, 5th Floor, Boston, MA 02108, 617-292-5859, joseph.cerutti@state.ma.us	Ross Micham, UIC Branch, U.S. EPA Region 5, 312-886-4237, micham.ross@epa.gov	Ross Micham, UIC Branch, U.S. EPA Region 5, 312-886-4237, micham.ross@epa.gov	Jimmy Sparks, Mississippi Department of Environmental Quality, UIC Program Manager, PO Box 2261, Jackson, MS 39225, 601-961-5640, jsparks@mdeq.ms.gov
State Agency regulating wells producing water	Dr. Ching-Tzone Tien, Chief, Groundwater Permits Division, Water Management Administration, Maryland Department of the Environment, 1800 Washington Boulevard, Baltimore, MD 21230, 410-537-3662, chin-tzone.tien@maryland.gov	Unknown	David DeYoung, Source Water Unit, Michigan Department of Environmental Quality, PO Box 30241, Lansing, MI 48909, 517-284-6526, deyoungd@michigan.gov	Kara Dennis, Minnesota Department of Health, Well Management, 651-201-4589, 626 North Robert Street, St. Paul, MN 55155-2538, kara.dennis@state.mn.us	Jimmy Sparks, Mississippi Department of Environmental Quality, UIC Program Manager, PO Box 2261, Jackson, MS 39225, 601-961-5640, jsparks@mdeq.ms.gov
State agency regulating non-producing boreholes	Unknown	Unknown	Closed-loops associated with a GHPS are not regulated under the state well code, regulated by counties.	Kara Dennis, Minnesota Department of Health, Well Management, 651-201-4589, 626 North Robert Street, St. Paul, MN 55155-2538, kara.dennis@state.mn.us	Unknown
Other units of government if part of permit process	Local Health Departments and other local Permitting Agencies (Approving Authorities) are delegated authority by MDE to enforce the State's water well construction regulations.	Local board of health/health department	Local health departments	Minnesota Department of Natural Resources	Unknown
Open-loop permit requirements	Unknown	Local well drilling permit required by board of health/health department and MassDEP UIC Registration application submitted for all geoexchange systems except single family homes.	Well construction permit issued by the local health department. Depending on the particular GHPS design, additional permits may be needed from the Department of Environmental Quality (DEQ).	Permit required by Minnesota Department of Health. An open-loop system that withdraws groundwater, directs that water through a heat exchanger, and then disposes of that water to the land surface or surface water requires a water appropriation permit from the Minnesota Department of Natural Resources (DNR) if more than 10,000 gallons/day or a million gallons/yr is withdrawn. Minnesota Statutes, section 103G.271, prohibits once-through cooling/heating systems that withdraw greater than 5 million gallons/yr..	Unknown
Closed-loop permit requirements	Unknown	Local well drilling permit required by board of health/health department.	Well construction permit issued by the local health department. Depending on the particular GHPS design, additional permits may be needed from the Department of Environmental Quality (DEQ).	Permit required by Minnesota Department of Health. A closed-loop system installed in the bed of a public water requires a public waters work permit from the Department of Natural Resources.	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown	Well driller submit a Well Completion Report to MassDEP and local board of health/health agent.	Not regulated by state, but counties.	Unknown	Unknown
Open-loop post-installation inspection/ reporting requirements			Inspection done after installation by local health department.		
Open-loop driller license requirements	Must be licensed with the MEP, MD State Board of Well Drillers	MassDEP Certified Well Driller	Certificate of Registration required from the Michigan Department of Environmental Quality	Licensed by Minnesota Department of Health	Unknown
Closed-loop driller license requirements	Must be licensed with the MEP, MD State Board of Well Drillers	MassDEP Certified Well Driller	Certificate of Registration required from the Michigan Department of Environmental Quality	Licensed by Minnesota Department of Health	Unknown
Are out of state drillers allowed to perform work?		Must be MassDEP Certified Well Driller	Out of state drillers must first be licensed/registered in another state to apply for Michigan registration.		
Comments on driller continuing ed requirements	Required. At this time (03/2017) 20 hours of continuing education are required each renewal period.	Unknown	Not required, just annual payment of $40.00	Continuing education required for annual license renewal	Unknown
Additional Notes and Comments	Unknown	MassDEP Guidelines for Ground Source Heat Pump Wells specifies recommended PE license/other training qualifications for the designer of the geoexchange systems.	See url for Michigan Best Practices for Geothermal Vertical Closed-Loop Installations. Michigan is not a UIC primacy state. The federal UIC program is implemented directly by the U.S. Environmental Protection Agency, Region V, Chicago, Illinois.	A bored geothermal heat exchanger must be installed by a well contractor or bored geothermal heat exchanger contractor licensed by the MDH.	Unknown
Additional information source(s) contact information	Unknown	Unknown	Unknown	Unknown	Unknown
URL of state agencies	Unknown	MassDEP Guidelines for Ground Source Heat Pump Wells http://www.mass.gov/eea/docs/dep/water/laws/a-thru-h/gshpguid.pdf ; UIC regulations http://www.mass.gov/eea/docs/dep/service/regulations/310cmr27.pdf. http://www.mde.state.md.us/programs/Permits/EnvironmentalBoards/boardofwelldrillers/Pages/index.aspx	http://www.michigan.gov/documents/deq/deq-wd-gws-wcu-ghpsguidance_195216_7.pdf; http://www.michigan.gov/documents/deq/dnre-wb-dwehs-wcu-bestpracticesgeothermal_311868_7.pdf	http://www.health.state.mn.us/divs/eh/wells/geothermal.html; http://www.health.state.mn.us/divs/eh/wells/lwc/; https://www.revisor.mn.gov/rules/?id=4725.1650	Underground Injection Wells page is currently under construction

	MISSOURI	MONTANA	NEBRASKA	NEVADA	NEW HAMPSHIRE
Agency issuing Underground Injection Control Permits	Justin Davis, Chief, Investigation and Remediation Unit, Wellhead Protection Section, Department of Natural Resources, Missouri Geological Survey, 111 Fairgrounds Road, Rolla, MO 65401, 573-368-2165, justin.davis@dnr.mo.gov	Omar Sierra-Lopez, Class V Well, U.S. EPA Region 8, (8WP-SUI), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov	Marty Link, Water Quality Div. Administrator, Nebraska Dept. of Environmental Quality, 1200 N. Street, Suite 400, Lincoln, NE 68509, 405-471-2909, marty.link@nebraska.gov	Russ Land, Nevada Division of Environmental Protection, UIC Program, 775-687-9428, rland@ndep.nv.gov	Steve Roy, Manager of Groundwater Permitting technical group, New Hampshire Department of Environmental Services, Drinking Water Source Protection Program, PO Box 95, Concord, NH 03302-0095, 603-271-3918 stephen.roy@des.state.nh.us
State Agency regulating wells producing water	Justin Davis, Chief, Investigation and Remediation Unit, Wellhead Protection Section, Department of Natural Resources, Missouri Geological Survey, 111 Fairgrounds Road, Rolla, MO 65401, 573-368-2165, justin.davis@dnr.mo.gov	The Environmental Protection Agency only regulates open loop ground source heat pumps. If proposed heat pump system does not need a permit, the system will be "rule authorized." Also regulated by Montana Department of Natural Resources and Conservation, 1424 Ninth Avenue, Helena MT 59620-1601, 406-444-2074 and Montana Department of Environmental Quality (if discharge).	Nancy Harris, 402-271-4290, nancy.harris@nebraska.gov	Unknown	Steve Roy, Manager of Groundwater Permitting technical group, New Hampshire Department of Environmental Services, Drinking Water Source Protection Program, PO Box 95, Concord, NH 03302-0095, 603-271-3918 stephen.roy@des.state.nh.us
State agency regulating non-producing boreholes	Unknown	Not regulated by state, just by local municipalities.	Tom 'Christopherson, 402-471-0598, tom.chiristopherson@nebraska.gov	Unknown	Steve Roy, Manager of Groundwater Permitting technical group, New Hampshire Department of Environmental Services, Drinking Water Source Protection Program, PO Box 95, Concord, NH 03302-0095, 603-271-3918 stephen.roy@des.state.nh.us
Other units of government if part of permit process	Unknown	The three permitting agencies include: The Environmental Protection Agency (EPA), Montana Department of Natural Resources and Conservation (DNRC), and the Montana Department of Environmental Quality (DEQ).	Nebraska Health and Human Services	Unknown	Unknown
Open-loop permit requirements	Installer must hold permit, but permit isn't site specific.	Department of Natural Resources and Conservation	UIC Authorization (Title 122)	Unknown	No permit required, UIC Registration form must be filed.
Closed-loop permit requirements	Installer must hold permit, but permit isn't site specific.	No permit requirement. Local municipality	Nebraska Health and Human Services (DHHS), 10+ loops must notify DHHS before construction	Unknown	No permit required, UIC Registration form must be filed (to register location of closed loop)
Closed-loop post-installation inspection/ reporting requirements	Unknown	Local municipality inspection	All wells registered with Nebraska Department of Natural Resources	Unknown	None
Open-loop post-installation inspection/ reporting requirements		Local municipality inspection	All wells registered with Nebraska Department of Natural Resources		An annual sampling requirement for non-residential systems.
Open-loop driller license requirements	Driller or installer is required to hold a "heat pump installation" permit through DNR	probably Well Drillers License	All well drillers must be licensed by Nebraska Health and Human Services	Unknown	License issued by NH Water Well Board required
Closed-loop driller license requirements	Driller or installer is required to hold a "heat pump installation" permit through DNR	probably Well Drillers License	All well drillers must be licensed by Nebraska Health and Human Services	Unknown	License issued by NH Water Well Board required
Are out of state drillers allowed to perform work?		not sure			Must have NH License from Water Well Board
Comments on driller continuing ed requirements	An apprenticeship requirement prior to issuance of an "unrestricted" permit. Continuing education is not required.	not sure	Continuing Ed required for all well drillers	Unknown	Not required for well drillers, but 2 hours of CE is required for pump installers.
Additional Notes and Comments	If installer doesn't intend to full-length grout the wells, then installer must pre-notify Investigation and Remediation Unit of DNR before beginning. Well or system owner will receive a certification letter and the installer will complete and return to DNR. Owner isn't required to get permit before installation.	The Department of Energy's GDOET program has compiled information from such analyses, which indicates that Montana has more than 25,000 square miles of high-potential sites and areas. Specific information for 50 geothermal sites is now available.	none	none	New Hampshire Safe Drinking Water Act, authorizing DES to adopt rules to regulate the heat exchange fluids used in closed loop geothermal systems and to prohibit the construction of open loop geothermal systems where such installations will contaminate freshwater aquifers with brackish or saline groundwater. Licensed pump installers are required by law, RSA 482-B:5, V, to obtain two continuing education hours annually as a condition for license renewal. The Water Well Board has adopted rules stipulating that continuing education must pertain to water pumps, water wells, or water conditioning and treatment systems.
Additional information source(s) contact information	Unknown	Ben Brouwer, Geothermal Energy Program, Montana Department of Environmental Quality, 1520n East 6th Avenue, Helena, MT 59601, 406-444-6586, bbrouwer@mt.gov	Unknown	Unknown	Unknown
URL of state agencies	Wellhead's webpage http://dnr.mo.gov/geology/geosrv/wellhd/index.html; Division 23, chapter 5 addresses heat pump construction requirements http://www.sos.mo.gov/adrules/csr/current/10csr/10csr.asp	http://deq.mt.gov/Energy/EnergizeMT/Geothermal; http://en.openei.org/wiki/RAPID/Geothermal/Montana	Nebraska Health and Human Services(DHHS) – Title 178 http://dhhs.ne.gov/publichealth/Pages/enh_wws_regs.aspx; NDEQ – Title 122 http://deq.ne.gov/RuleAndR.nsf/Title_122.xsp	http://ndep.nv.gov/bwpc/uic01.htm	https://www.des.nh.gov/organization/divisions/water/dw; https://www.des.nh.gov/media/pr/2010/20100112.htmgb/wwb/; https://www.des.nh.gov/organization/divisions/water/dwgb/wwb/education.htm

	NEW JERSEY	MEW MEXICO	NEW YORK	NORTH CAROLINA	NORTH DAKOTA
Agency issuing Underground Injection Control Permits	Eleanor Krukowski, Supervising Environmental Specialist, New Jersey Department of Environmental Protection, Division of Water Quality, Trenton, NJ 08625-0029, 609-292-0407, eleanor.krukowski@dep.state.nj.us	Greg Huey, Ground Water Quality Bureau, New Mexico Environment Department, Harold Runnels Building Room M2250, 1190 St. Francis Drive, Santa Fe, NM 87505, 505-827-6891, greg.huey@state.nm.us	Rob Ferri, US EPA Region 2, 212-637-4227, ferri.robert@epa.gov290 Broadway, 20th Floor, New York, NY	Michael Rogers, North Carolina Department of Environment Quality, 919-807-6338, michael.rogers@ncdenr.gov	North Dakota Department of Health, Division of Water Quality, UIC, Carl Anderson, 701-328-5210, cjanders@nd.gov
State Agency regulating wells producing water	Unknown	Unknown	Unknown	Michael Rogers, North Carolina Department of Environment Quality, 919-807-6338, michael.rogers@ncdenr.gov	North Dakota Department of Health, Division of Water Quality, UIC, Carl Anderson, 701-328-5210, cjanders@nd.gov
State agency regulating non-producing boreholes	Unknown	Unknown	Unknown	Unknown	Unknown
Other units of government if part of permit process	Unknown	Unknown	Unknown	Specific type of geothermal heat pump system determines necessary permits/notification.	Unknown
Open-loop permit requirements	Permit required by NJ DEP	Unknown	Unknown	State permit required	UIC Requirements
Closed-loop permit requirements	Permit required by NJ DEP	Unknown	Unknown	State permit not required, but need to file Notice of Intent prior to construction, County/municipality may have additional requirements.	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Unknown	Unknown	Unknown
Open-loop post-installation inspection/ reporting requirements			Unknown	Post construction of well and heat pump, inspector will inspect well and collect necessary samples.	Unknown
Open-loop driller license requirements	Licensed well plumber per state of NJ	Unknown	Unknown	Certified Well Driller's license required per Well Contractors Certification Commission	Unknown
Closed-loop driller license requirements	Licensed well plumber per state of NJ	Unknown	Unknown	Certified Well Driller's license	Unknown
Are out of state drillers allowed to perform work?			Unknown	Unknown	Unknown
Comments on driller continuing ed requirements	Unknown	Unknown	Unknown	CE required	Unknown
Additional Notes and Comments	Unknown	Unknown	Unknown	Only HVAC contractors licensed by the State Board of Examiners of Plumbing, Heating and Fire Sprinkler Contractors may install heat exchange tubing into a well/borehole.	Unknown
Additional information source(s) contact information	Unknown	The Ground Water Quality Bureau will be proposing revisions to the WQCC regulations for Ground and Surface Water Protection (20.6.2 NMAC) in Spring 2017. If you would like to receive updates on this process please contact Steve Huddleson, manager of the Pollution Prevention Section, at (505) 827-2936.	Unknown	Unknown	Lorraine Manz, Geological Survey Div., 701-328-8005
URL of state agencies	http://www.state.nj.us/dep/dwq/; http://www.state.nj.us/dep/exams/docs/subsurf_perc_water_act.pdf	https://www.env.nm.gov/gwb/;	Unknown	https://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/ground-water-protection/injection-wells; https://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/ground-water-protection/geothermal	http://ndhealth.gov/WQ/GW/uic.htm;

	OHIO	OKLAHOMA	OREGON	PENNSYLVANIA	RHODE ISLAND
Agency issuing Underground Injection Control Permits	Lindsay Taliferro, Ohio Environmental Protection Agency, 614-644-2771, lindsay@taliaferro@epa.state.oh.us	Hilary Young, Chief Engineer, Land Protection Division, Oklahoma Department of Environmental Quality, 707 N Robinson, PO Box 1677, Oklahoma City, OK 73101-1677, 405-702-5188, hilary.young@deq.ok.gov	Derek Sandoz, Oregon Department of Environmental Quality, 503-229-5099, sandoz.derek@deq.state.or.us	Mark Nelson, EPA Region 3, Class V Team Leader and Technical Representative, UIC Class 5 Permitting and Rule Authorization, 1060 Chapline Street, Wheeling, WV 26003-2995, 304-234-0286, nelson.mark@epa.gov	Craig Roy, Rhode Island of Environmental Management, Office of Water Resources, craig.roy@dem.ri.gov
State Agency regulating wells producing water	Andrew Adgate, Ohio Department of Natural Resources, UIC, 614-265-6673, andrew.adgate@dnr.state.oh.us	Hilary Young, Chief Engineer, Land Protection Division, Oklahoma Department of Environmental Quality, 707 N Robinson, PO Box 1677, Oklahoma City, OK 73101-1677, 405-702-5188, hilary.young@deq.ok.gov	ReNeea Lofton, Natural Resource Specialist, Oregon Department of Geology and Mineral Industries, 541-967-2040, reneea.lofton@oregon.gov	No state level regulation; regulated by county/township	Unknown
State agency regulating non-producing boreholes	Unknown	Unknown	Unknown	No state level regulation; regulated by county/township	Unknown
Other units of government if part of permit process	Unknown	Unknown	Unknown	Department of Conservation and National Resources	Unknown
Open-loop permit requirements	Unknown	No permit required, inventory requirement for Class V injection wells	Unknown	Permit required	Unknown
Closed-loop permit requirements	Unknown	Unknown	Unknown	Permit required	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Unknown	Unknown	Unknown
Open-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Unknown	Unknown	Unknown
Open-loop driller license requirements	Unknown	Well driller licensed by Oklahoma Water Resources Board (OWRB)		All well drillers must be licensed by PA Department of Conservation and National Resources	Unknown
Closed-loop driller license requirements	Unknown	Well driller licensed by Oklahoma Water Resources Board (OWRB)	Unknown	All well drillers must be licensed by PA Department of Conservation and National Resources	Unknown
Are out of state drillers allowed to perform work?	Unknown	Unknown	Unknown	Yes, after obtaining a license from the state of PA	Unknown
Comments on driller continuing ed requirements	Unknown	Unknown	Unknown	No continuing ed requirement	Unknown
Additional Notes and Comments	Unknown	Unknown	Unknown	Unknown	Unknown
Additional information source(s) contact information	Unknown	Oklahoma Corporation Commission (OCC), please contact the OCC Oil and Gas Division at (405) 521-2302	Unknown	Stuart Reese, Geologist Manager, PA Department of Conservation and Natural Resources, Pennsylvania Geological Survey, 3240 Schoolhouse Road, Middletown, PA 17057-3534, 717-702-2028, streese@pa.gov	Unknown
URL of state agencies	http://www.epa.ohio.gov/ddagw/uic.aspx#114042767-class-v-wells	http://www.deq.state.ok.us/lpdnew/UIC/UIC.html; http://www.owrb.ok.gov/about/about_pdf/Fact-WellDrillerLicensing.pdf	https://www.oregon.gov/energy/At-Home/Pages/Geothermal-Heat-Pumps.aspx; http://www.oregongeology.org/mlrr/geothermal.htm	http://www.dcnr.state.pa.us/topogeo/groundwater/gw_privwells/index.htm	Unknown

	SOUTH CAROLINA	SOUTH DAKOTA	TENNESSEE	TEXAS	UTAH
Agency issuing Underground Injection Control Permits	Bruce Crawford, IUC Program, South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201, 803-898-4177, crawfobd@dhec.sc.gov	Omar Sierra-Lopez, Class V Well, U.S. EPA Region 8, (8WP-SUI), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov	Scotty Sorrells, Tennessee Department of Environment and Conservation, Division of Water Resources, 312 Rosa L. Parks Ave Nashville, TN 37243, 615-532-9224, scotty.sorrells@tn.gov	Lorrie Council, Texas Commission on Environmental Quality, PO box 13087, Austin, TX 78711-3087, 512-239-6461, lorrie.council@teq.texas.gov	Candace Cady, Utah Department of Environmental Quality, Division of Water Quality UIC, 195 North 1950 West Salt Lake City, UT 84116, ccady@utah.gov
State Agency regulating wells producing water	Bruce Crawford, IUC Program, South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201, 803-898-4177, crawfobd@dhec.sc.gov	Unknown	Unknown	Unknown	Candace Cady, Utah Department of Environmental Quality, Division of Water Quality UIC, 195 North 1950 West Salt Lake City, UT 84116, ccady@utah.gov
State agency regulating non-producing boreholes	Unknown	Unknown	Unknown	Unknown	Unknown
Other units of government if part of permit process	Unknown	Unknown	Unknown	Unknown	Unknown
Open-loop permit requirements	A permit is required from the SCDHEC prior to constructing, operating or using V. A. well for injection.	Unknown	Underground Injection Control permit required	Unknown	UIC Requirements
Closed-loop permit requirements	A permit is required from the SCDHEC prior to constructing, operating or using V. A. well for injection.	Unknown	Unknown	Unknown	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Unknown	The Texas Department of Licensing and Regulation state well report form shall be completed and submitted to the executive director within 30 days from the date the well construction is completed. Any additives, constituents, or fluids (other than potable water) that are used in the closed loop injection well system shall be reported in the Water Quality Section on the state well report form	Unknown
Open-loop post-installation inspection/ reporting requirements	Unknown	Unknown	Unknown	After completion of construction. Except for large capacity septic systems, subsurface fluid distribution systems, temporary injection points, closed loop injection wells, improved sinkholes, and air conditioning return flow wells, the Texas Department of Licensing and Regulation state well report form shall be submitted to the executive director within 30 days from the date the well construction is completed.	Unknown
Open-loop driller license requirements	Injection may not commence until the SCDHEC has inspected or otherwise reviewed the injection well and finds it in compliance with regulations.	Unknown	Well Driller License required	Water well driller licensed by Texas Department of Licensing and Regulation required. A person may not act or offer to act as a driller or pump installer unless the person is licensed or registered by the executive director pursuant to the Code. A licensee, not licensed to perform all types of well drilling and pump installation, may apply for endorsements. Upon examination of the applicant's qualifications, the executive director must deny or grant additional endorsements to an existing license.	Utah Well Driller's License required
Closed-loop driller license requirements	Unknown	Unknown	Well Driller License required	A person may not act or offer to act as a driller or pump installer unless the person is licensed or registered by the executive director pursuant to the Code. A licensee, not licensed to perform all types of well drilling and pump installation, may apply for endorsements. Upon examination of the applicant's qualifications, the executive director must deny or grant additional endorsements to an existing license.	Utah Well Driller's License required
Are out of state drillers allowed to perform work?	Unknown	Unknown	Unknown	Unknown	Unknown
Comments on driller continuing ed requirements	Unknown	Unknown	Unknown	Water Well Driller or Pump Installer licensees must complete four (4) hours of continuing education in courses approved by the department.	Unknown
Additional Notes and Comments	Unknown	Unknown	Class V wells generally are authorized by reference in the Tennessee Rules for Underground Injection Control. In this case, the applications are reviewed within two (2) to four (4) weeks. If the proposed project is complex, the Division will issue a permit rather than an authorization. A permit may take up to six (6) months to process.	Unknown	See R655-4-11 for Well Drilling & Construction Requirements; R655-4-12 Special Wells Regulations; Geothermal wells are subject to Section 73-22-1 "Utah Geothermal Resource Conservation Act" Utah Code Annotated and the rules promulgated by the state engineer including Section R655-1, Wells Used for the Discovery and Production of Geothermal Energy in the State of Utah
Additional information source(s) contact information	Christopher Wargo, SCDHEC, 803-898-3799, wargoca@dhec.sc.gov	Unknown	Unknown	Unknown	Jim Goddard, Utah Division of Water Rights, 801-538-7314, jimgoddard@utah.gov
URL of state agencies	http://www.scdhec.gov/Environment/docs/gduic.pdf; http://www.scdhec.gov/environment/docs/r61-87.pdf;	Unknown	http://www.tn.gov/environment/article/wr-wq-underground-injection-control; http://www.tn.gov/environment/article/permit-water-underground-injection-control-permit#sthash.4ZNaeNqI.dpuf	https://www.tdlr.texas.gov/wwd/wwdce.htm; https://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=331&rl=132https://www.tdlr.texas.gov/wwd/wwdrules.htm; https://www.tceq.texas.gov/permitting/waste_permits/uic_permits/uic.htmll	https://rules.utah.gov/publicat/code/r655/r655-004.htm;

	VERMONT	VIRGINIA	WASHINGTON	WEST VIRGINIA	WISCONSIN
Agency issuing Underground Injection Control Permits	Darlene Autery, Vermont Department of Environmental Conservation, Drinking Water and Groundwater Protection Division, darlene.autery@state.vt.us	Mark Nelson, EPA Region 3, Class V Team Leader and Technical Representative, UIC Class 5 Permitting and Rule Authorization, 1060 Chapline Street, Wheeling, WV 26003-2995, 304-234-0286, nelson.mark@epa.gov	Mary Shaleen Hansen, Water Quality Program, Washington Department of Ecology, PO Box 47600, Olympia, WA 98504-7600, 360-407-6143, maha461@ecy.wa.gov	Terri L. Sangid, Environmental Resources Program Manager, Stormwater & Groundwater/UIC Programs, West Virginia Division of Environmental Protection, 601 57th Street SE, Charlestown, WV 25304, 304-926-0499, ext. 1285, terrie.l.sangid@wv.gov	Brian Austin, Water Supply Specialist, Division of Environmental Management, Wisconsin Department of Natural Resources, PO Box 7921, Madison, WI 53707-7921, 608-266-3415, brian.austin@wisconsin.gov.
State Agency regulating wells producing water	Darlene Autery, Vermont Department of Environmental Conservation, Drinking Water and Groundwater Protection Division, darlene.autery@state.vt.us	Matthew Link, Permit Writer, Virginia Department of Environment Quality, PO Box 1105, Richmond, VA 23218, 804-698-4078, matthew.link@deq.virginia.gov	Mary Shaleen Hansen, Water Quality Program, Washington Department of Ecology, PO Box 47600, Olympia, WA 98504-7600, 360-407-6143, maha461@ecy.wa.gov		Brian Austin, Water Supply Specialist, Division of Environmental Management, Wisconsin Department of Natural Resources, PO Box 7921, Madison, WI 53707-7921, 608-266-3415, brian.austin@wisconsin.gov.
State agency regulating non-producing boreholes	Unknown	Unknown	Unknown	Unknown	Unknown
Other units of government if part of permit process	Unknown	Unknown	State of Washington, Department of Ecology, 360-407-6648 or 7122; Department of Labor and Industries (LNI), and local health departments	Unknown	Unknown
Open-loop permit requirements	Permit required but are exempt from UIC permitting if certain conditions are met. See Section 11-320(b) and 11-303(a)(2)	Unknown	UIC Permit required. Before drilling a well, you must submit a notice of intent (NOI) to the Department of Ecology. This document needs to be submitted to Ecology 72 hours before the well is drilled.	Unknown	Injection Well Inventory Form must be submitted to Wisconsin's Department of Natural Resource's Bureau of Drinking Water and Groundwater
Closed-loop permit requirements	Unknown	Unknown	Before drilling a well, you must submit a notice of intent (NOI) to the Department of Ecology. This document needs to be submitted to Ecology 72 hours before the well is drilled.	Unknown	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown	Unknown	A well report must be mailed to the nearest Ecology regional office servicing that particular county within 30 days after completing well.	Unknown	Unknown
Open-loop post-installation inspection/ reporting requirements	Unknown	Unknown	A well report must be mailed to the nearest Ecology regional office servicing that particular county within 30 days after completing well.	Unknown	Unknown
Open-loop driller license requirements	Vermont Well Driller's License required	Unknown	A water well operator license is required for all operators engaged in constructing or decommissioning water wells. A resource protection well operator license is required for all operators engaged in constructing or decommissioning resource protection wells and geotechnical soil borings.	Unknown	A Wisconsin license or registration is required to engage in the businesses of water well drilling, pump installing and heat exchange drilling
Closed-loop driller license requirements	Vermont Well Driller's License required	Unknown	A water well operator license is required for all operators engaged in constructing or decommissioning water wells. A resource protection well operator license is required for all operators engaged in constructing or decommissioning resource protection wells and geotechnical soil borings.	Unknown	A Wisconsin license or registration is required to engage in the businesses of water well drilling, pump installing and heat exchange drilling
Are out of state drillers allowed to perform work?	May be accepted in lieu of requirements in sections15-503© and (d) and 15-504 of the Environmental Protection Rule and if reciprocal agreement is in place between Department and licensing body for that state, territory or province. Applicant required to pass Vermont licensing test.	Unknown	Out of state licensed drillers must submit a completed application to the department, pay an application fee, have obtained 32 continuing education units as approved by the department, pass a written examination as provided for in RCW 18.104.080, and pass an on-site examination by the department (the on-site examination may be waived by the department). Proof of licensing under (c)(i)(B) of this subsection shall be submitted with the application for license. Proof of drilling experience may include drilling logs, federal or state tax records; employment records; or other records acceptable to the department.	Unknown	Drillers seeking reciprocity for licensing in another state must complete the Heat Drillers License Application (Form 3300-300), Experience Voucher for Individual Heat Exchange Applicant (Form 3300-301) and the Out-of-State Individual Heat Exchange Driller License Application (Form 3300-302).
Comments on driller continuing ed requirements	Unknown	Unknown	Must complete fourteen continuing education units during the past twenty-four months of the license term. A minimum of two continuing education units out of the fourteen required units must be about Washington state drilling or licensing regulations	Unknown	Each licensed or registered individual is required to obtain continuing education credits every year to be eligible to renew a license or registration for the following year.
Additional Notes and Comments	Well drilling is regulated by the Water Supply Section	Unknown	Class V wells are allowed in Washington if they can meet the requirements of Chapter 173-218 WAC (Underground Injection Control Program) and Chapter 173-200 WAC (Water Quality Standards for Ground Waters of the State of Washington). Public work, including publicly-funded projects, must comply with the Department of Labor and Industries (LNI) prevailing wage requirements as well as Ecology's regulations for well drilling.	Unknown	Unknown
Additional information source(s) contact information	Rodney Pingree, State of Vermont, Environmental Conservation, One National Life Drive, Montpelier, VT05620, 802-585-4912, roeney.pingree@vermont.gov	Unknown	Unknown	Unknown	Unknown

URL of state agencies	http://dec.vermont.gov/sites/dec/files/dwgwp/welldriller/pdf/welldrillerlicensingrulesigned2002.pdf; http://dec.vermont.gov/water/underground-injection-controlhttp://dec.vermont.gov/water/programs/well-drillers;	http://www.ecy.wa.gov/programs/wq/grndwtr/uic/index.html;
		http://www.ecy.wa.gov/programs/wq/grndwtr/uic/registration/class5types.html;
		http://apps.leg.wa.gov/WAC/default.aspx?cite=173-218;
		http://apps.leg.wa.gov/WAC/default.aspx?cite=173-200
			http://www.ecy.wa.gov/programs/wr/wells/wellhome.html;
			http://apps.leg.wa.gov/wac/default.aspx?cite=173-162;
			http://apps.leg.wa.gov/wac/default.aspx?cite=173-162-080;
			http://www.oria.wa.gov/site/alias__oria/463/default.aspx;
				Unknown	http://dnr.wi.gov/topic/Wells/UIW.html;
					http://dnr.wi.gov/topic/Wells/Geothermal.htmlhttp://dnr.wi.gov/topic/wells/licenses.html

	WYOMING
Agency issuing Underground Injection Control Permits	Kathy Schreve, Wyoming Department of Environmental Quality, UIC Program, 200 West 17th Street, Cheyenne, WY 82002 307-777-6682, kathy.shreve@wyo.gov
State Agency regulating wells producing water	Kathy Schreve, Wyoming Department of Environmental Quality, UIC Program, 200 West 17th Street, Cheyenne, WY 82002 307-777-6682, kathy.shreve@wyo.gov
State agency regulating non-producing boreholes	State of Wyoming, Office of the State Engineer, Herschler Building 4-E, Cheyenne, WY 82002, 307-777-6163
Other units of government if part of permit process	Unknown
Open-loop permit requirements	UIC Requirements; A permit to appropriate ground water must be obtained from the State Engineer prior to commencing construction of the well.
Closed-loop permit requirements	Unknown
Closed-loop post-installation inspection/ reporting requirements	Unknown
Open-loop post-installation inspection/ reporting requirements	Unknown
Open-loop driller license requirements	Unknown
Closed-loop driller license requirements	Unknown
Are out of state drillers allowed to perform work?	Applicants who are currently licensed in states other than Wyoming are only required to take the Wyoming Specific Exam for General Contractors.
Comments on driller continuing ed requirements	All license holders renewing their license will be required as a condition of renewal, to have completed eighteen (18) CPC units in each renewal period. Each Water Well Driller's License renewal shall require nine (9) CPC Units from within subsection (d)(I), (d)(ii) and/or (d)(iii) described below and directly pertaining to water well construction.
Additional Notes and Comments	Unknown
Additional information source(s) contact information	Unknown
URL of state agencies	http://deq.wyoming.gov/wqd/underground-injection-control/; http://wwcb.state.wy.us/PDF/RulesAndRegulations/WaterWellMinimumConstructionStandards.pdfhttp://wwcb.state.wy.us/PDF/RulesAndRegulations/RulesandRegulations2015.pdf